

between them. The laws of phenomena proceed from causes, and causes assorted so as to produce these laws, and so they are the most direct and effectual means of enabling us to trace the causes. It was the steady contemplation of the laws of phenomena discovered by Kepler which furnished Newton with the data on which he proceeded, in forming a correct theory of the causes of the visible motions of the planetary bodies. We thus perceive, that as the discovery of the laws of phenomena generally precedes the discovery of causes, so the former is the most certain means of reaching the latter. We can account in this manner for the nature of that progress which Whewell has traced so beautifully in the development of science.

(3.) In doing so, however, we must take into account the third general truth which we have enunciated—that causes require adjustments as the condition of their operation. There is something more in the true cause of the heavenly motions than the mere property of gravitation; there are adjusted relations of space and time. These had to be taken into account by Newton before he could establish his doctrine of universal gravitation. The laws of Kepler related to the adjustments of time and space—they related to this orbit of the planets, and the times of the planets' revolutions; and were thus the means of enabling the mind of Newton to grasp the whole complex cause. It is a curious circumstance, and a proof of the necessity of taking such relations into account, that an erroneous calculation of the relative distance of the earth's surface and of the moon from the earth's centre led Newton for a time to lay aside his theory. The discovery of Newton was made through a steady apprehension of the distances of the heavenly bodies, the times of their revolutions, and the laws of force and motion, being the conditions necessary for the operation of the cause.

By not taking into view the general truth now referred to, Whewell, as it appears to us, has fallen into a grievous mistake. He speaks of the philosopher's ideas of space and time as giving coherence to the phenomena which he observes, and everywhere talks of these ideas superinducing upon nature something which does not actually exist. (See App. XI.) Now, the correct expression seems to us rather to be, that those who possess adequate and clearly conceived notions of space and time are enabled to discover the relations of space and time which are to be found in the works of nature, and which are so necessary to their operation. The mind, as Whewell shows, must be active in making scientific discoveries, or even in apprehending scientific facts; but its activity consists not in adding to phenomena relations which do not exist in nature, but in apprehending, by means of the active intellectual faculties, the relations which are needful in order to the beneficial action of the works of God. It is because the relations of space and time are, involved as conditions in the operation of universal gravitation, that the science which has to do with space and

time (we mean the natural laws) furnishes much aid in astronomy. Hence, too, the necessity on the part of all who would successfully prosecute astronomy, of clear ideas of space and time. This does not arise, as Whewell seems to think, from the circumstance of these ideas being needful to improve upon the facts which astronomy presents something which has no reality, but from the circumstance that these ideas are necessary in order to enable us to discover the relations that actually exist.

On the supposition that the undulatory theory of light is correct, one may observe the same three general truths, and by them explain the progress made in this department of science. The undulations being regular in a homogeneous ether, must produce certain general results which were noticed in the first